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RESEARCH MEMORANDUM

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Japanese Labour Productivity and Unit Labour Cost in Manufacturing in Comparison to the U.S.

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Abstract: This paper looks at several measures of competitiveness for the Japanese manufacturing sector relative to the United States over the period 1980-2000. Using industry-specific unit-value ratios (UVRs) we show that labour productivity in Japanese manufacturing lags considerably behind the U.S. and that the Japanese position has worsened during the 1990s. In 2000, value added per hour worked in Japanese manufacturing stood at 72 percent of the U.S. level after peaking at 79 percent in 1991. Underneath this aggregate estimate though, there is a wide range of branch-specific labour productivity levels. Japanese manufacturing has also suffered from rising unit labour cost levels. The long-term trend of a strengthening yen has eroded Japanese cost competitiveness in nearly all branches between 1980 and 2000, although ULC levels have declined somewhat from 1995 onwards due to a more favourable exchange rate development and moderate wage growth in Japan. Still, in 2000 unit labour cost in Japanese manufacturing was still 27 percent above the U.S. level. In comparison, in 1980 Japanese unit labour cost stood at only 82 percent of the U.S. level.

1. Introduction

Compared to the 1980s the economic growth experiences of the United States and Japan have reversed during the 1990s. Between 1980 and 1991 the average Japanese GDP growth rate was much higher than in the United States. However, since the stock market and housing bubble burst, the Japanese economy has limped from one recession to the other. At the same time, however, the U.S. economy has regained its strength. Especially since 1995, U.S. output and productivity growth has increased sharply led by the widespread adoption of Information and Communication Technologies (ICT). Although the 2001 recession has dampened enthusiasm somewhat, the U.S. economy still looks to be in considerably better shape than the Japanese economy. Table 1 confirms the general trend with strong Japanese growth in the total economy before 1991, reviving U.S growth and sagging Japanese growth between 1991 and 1995 and strong U.S. growth after 1995.

Table 1, Average annual growth in output, labour input and labour productivity in the total economy and in manufacturing in Japan and the United States between 1980 and 2000

	1980-1991		1991-1995		1995-2000	
	Japan	U.S.	Japan	U.S.	Japan	U.S.
Total economy						
Output	4.2	2.7	0.5	2.8	1.1	4.5
Employment	1.0	1.6	0.4	1.6	-0.1	2.0
Hours worked per person	-0.3	-0.1	-1.2	0.3	-0.5	0.0
Labour productivity	3.4	1.2	1.3	0.9	1.6	2.5
Manufacturing						
Output	5.9	2.5	0.1	5.0	2.4	4.6
Employment	1.1	-0.8	-1.4	0.1	-1.5	-0.1
Hours worked per person	-0.4	0.2	-1.1	0.7	-0.1	-0.1
Labour productivity	5.1	3.1	2.6	4.1	4.1	4.8

Notes: Applying U.S. deflators for ICT industries and using Törnqvist index to aggregate industry data
Sources: see Appendix A

A similar picture emerges for the manufacturing sector. During the 1980s Japanese output and productivity growth in manufacturing was much faster than in the U.S., leading to a continuous narrowing of the productivity gap relative to the U.S. But Japanese manufacturing output growth collapsed during the early 1990s while U.S. growth doubled. Indeed the U.S. manufacturing sector received a strong boost from technological progress in the ICT-producing industries.[1] Although the manufacturing sector in advanced countries is generally characterized by stagnating or declining employment, Japanese employment declined at a much faster pace than in the United States. A closer look at the manufacturing sector may be particularly revealing from the point of view of international competitiveness.

[1] See for example van Ark, *et al.* (2002) and references therein.

To accurately measure price competitiveness we calculate industry-specific purchasing power parities (PPPs) using the ICOP industry-of-origin approach.[2] These PPPs are used to calculate relative labour productivity levels in 17 manufacturing branches for 1997 and the period 1980-2000. The PPP calculations show that, despite significant movements in the yen/dollar exchange rate, the relative manufacturing price level in Japan has been well above the U.S. since the mid-1980s. At the same time the manufacturing productivity gap between Japan and the U.S. has widened by 7 percentage points from 21 percentage points in 1991 to more than 28 percentage points in 2000.

We also look at cost competitiveness by calculating relative unit labour cost levels for the manufacturing sector. This indicator shows the relative cost of labour input to produce a unit of output in Japan compared to the United States. Relative unit labour cost over this period has been influenced by sharp fluctuations in the yen/dollar exchange rate, which is used to convert Japanese labour cost to U.S. dollars. But in general the competitiveness of Japanese manufacturing products has suffered from a strengthening yen relative to the U.S. dollar, declining relative productivity levels and high labour cost levels. As a result Japanese output from nearly all branches is produced at higher unit labour cost than their U.S. counterparts.

The remainder of the paper is organized as follows. The next section gives an overview of the ICOP methodology. In section 3 we will present the results of the 1997 benchmark comparison between Japan and the United States. This comparison covers the manufacturing sector as a whole and 17 manufacturing branches. Section 4 deals with the analysis of the Japan-U.S. labour productivity gap. Section 5 is devoted to the change in relative labour productivity levels in Japan versus the U.S.. In section 6, we report our estimates of unit labour cost levels and its development since 1987. Section 7 presents some conclusions.

2. Methodology

For this study, we calculate Purchasing Power Parities (PPPs) following the industry-of-origin approach as developed in the International Comparisons of Output and Productivity (ICOP) project of the University of Groningen. The methodology has been used and described in many studies, including van Ark (1993), Pilat (1994), van Ark and Pilat (1993) and Timmer (2000). OECD (2003) covers this method extensively in a reader on measuring productivity levels. Hence we limit ourselves to a summary description of the ICOP methodology.

The aim of the ICOP method is to derive industry-specific currency conversion factors on the basis of relative product prices. As a first step, unit values (uv) are derived by dividing ex-factory output values (o) by produced quantities (q) for each product i in each country

$$uv_i = \frac{o_i}{q_i}, \tag{1}$$

[2] See van Ark and Pilat (1993) for the previous benchmark ICOP comparison of Japanese manufacturing relative to the United States. See Jorgenson, Kuroda and Nishimizu (1987), Jorgenson and Kuroda (1990), Jorgenson and Kuroda (1992) or Kuroda (1996) for other estimates of Japan-U.S. productivity gaps. Van Ark and Timmer (2001), OECD (2003) extensively discuss some of the problems and advantages of the ICOP method.

The unit value can be considered as an average price, averaged throughout the year for all producers and across a group of nearly similar products. Subsequently, in a bilateral comparison, broadly defined products with similar characteristics are matched, for example ladies' shoes, cigarettes, cheese and car tyres. For each matched product, the ratio of the unit values in both countries is taken. This unit value ratio (UVR) is given by

$$UVR_i^{xu} = \frac{uv_i^x}{uv_i^u}, \tag{2}$$

Here, x and u are the countries that are compared. The base country, in this case the U.S., is denoted by u. The product UVR indicates the relative producer price of the matched product in the two countries.

Product UVRs are used to derive UVRs at more aggregated levels in a stepwise procedure. Within manufacturing, product UVRs are first aggregated to industries, then to branches and finally to aggregate manufacturing.[3] The industry UVR (UVR_j) is given by the weighted average of the UVRs of the matched products. Product UVRs are weighted by their output value as more important products should have a bigger weight in the industry UVR:

$$UVR_j = \sum_i w_{ij} UVR_{ij}^{xu} \tag{3}$$

with i=1,.., I_j the matched products in industry j; $w_{ij} = o_{ij} / o_j$ the output share of the i^{th} commodity in industry j; and $o_j = \sum_i o_{ij}$ the total matched value of output in industry j. In bilateral comparisons the weights of the base country (u) or the other country (x) can be used, which provide a Laspeyres and a Paasche type UVR respectively. The geometric average of the Laspeyres and Paasche indices, i.e. the Fisher index, is used when a single currency conversion factor is required. The next aggregation step is made by using the gross output of industries to obtain an industry-weighted mean of all industry UVRs in a branch, similarly to the aggregation from product to industry. Again gross output weights from country base country u and the other country x can be used to arrive at Laspeyres and Paasche index of the branch UVRs. The latter step is repeated for the final aggregation step from branch level to the level of total manufacturing.

3. The Japan-U.S. 1997 Benchmark Comparison

3.1 Estimation of Unit Value Ratios (UVRs)

The benchmark comparison for Japan versus the U.S. was largely done on the basis of product information from the *1997 Economic Census* for the U.S. and the *Census of Manufacturers 1997* for Japan. Some secondary sources were also used such as a price survey for intermediate goods from MITI.[4] Using these sources we arrive at a total number of 224 unit value ratios, which account for 19.5 percent of U.S. manufacturing output and 21.1 percent of Japanese manufacturing output. Table 2 gives an overview of the manufacturing branch UVRs and output coverage ratios. Coverage by

[3] Within ICOP, the total manufacturing sector is subdivided into 14-16 more homogeneous branches (equal to the 2 digit ISIC level), which are subsequently subdivided into industries (equal to 3 or 4 digit ISIC level).
[4] Appendix A contains details on the exact data used from the Census and other sources.

manufacturing branch differs significantly, mainly reflecting differences in the availability of product data.
For example, in rubber and plastics coverage was only 5.9 percent and 7.5 percent for the U.S. and Japan respectively, but it was 74.9 percent and 49.3 percent for petroleum and coal products.[5]

For some manufacturing branches the UVR estimates deserve additional comment. First of all, the UVR for food products is among the highest in Japan, which has a large effect on the UVR for total manufacturing due to the importance of the branch. It is well known that agricultural products are much more expensive in Japan than in other countries such as the United States and that the market for food products is strongly protected. As agricultural products are an important input for the food products branch, the output price in this branch will automatically be much higher relative to the U.S., even though the (implicit) value added price is lower. As our value added PPPs are directly obtained from the gross output unit values, the former is upwardly biased when no account is taken of the relatively high price ratio of intermediate products (in this case, agricultural products). Van Ark and Pilat (1993) remedy this problem by applying a double deflation procedure to obtain their 1987 UVR for food products, which adjusts differences in output prices for differences in prices of intermediate inputs. Here we follow a similar procedure. We calculate an intermediate input PPP for food products using industry-specific PPPs from van Ark, Stuivenwold and Inklaar (2003) in combination with intermediate input shares from the 1997 Input/Output tables of the OECD Input/Output database. The PPP for agricultural products of 654 Yen/$ has an especially large effect on the results. We then combine the resulting intermediate input PPP of 412 yen/US$ and the gross output PPP of 294 yen/US$ to yield the double deflated PPP of 216 yen/US$ in Table 2.

[5] If we would only have used data directly from the Census, the coverage percentage drops to 12.9 percent for the U.S. and 13.7 percent for Japan. The zero percent coverage in office, computing and accounting machinery is due to the use of a PPP from Gersbach and van Ark (1994), which does not cover a specific part of output of the branch.

Table 2, Unit value ratios for the Japan-U.S. comparison and measures of reliability, 1997

	Laspeyres UVR Yen/US$	Paasche UVR Yen/US$	Fisher UVR Yen/US$	Number of UVRs	Coverage ratio U.S. %	Coverage ratio Japan %	Coefficient of variation Laspeyres	Coefficient of variation Paasche
Food and kindred products[a)]	216	216	216	23	13.2	17.0	0.230	0.099
Textile mill products	163	141	152	15	34.7	37.6	0.075	0.104
Wearing apparel	186	153	169	18	42.1	32.1	0.047	0.094
Leather products and footwear	296	175	227	12	61.5	48.5	0.039	0.091
Wood products	353	193	261	3	17.6	48.4	0.282	0.330
Paper products, printing and publishing	165	142	153	8	10.7	10.6	0.107	0.078
Chemicals and allied products	183	152	167	38	14.6	16.7	0.074	0.162
Petroleum and coal products	174	131	151	9	74.9	49.3	0.067	0.110
Rubber and plastic products	124	106	115	4	5.9	7.5	0.153	0.129
Non-metallic mineral products	140	114	127	11	40.1	29.6	0.098	0.063
Basic metal products	142	118	130	37	39.5	40.7	0.045	0.053
Fabricated metal products	212	147	177	9	4.2	16.2	0.192	0.194
Machinery and equipment	130	93	110	19	4.2	10.5	0.158	0.116
Transport equipment	142	117	129	5	27.3	28.4	0.044	0.168
Office, accounting and computing machinery[b)]	127	127	127	1	0.0	0.0	0.000	0.000
Electrical machinery and instruments	99	98	99	12	17.5	17.1	0.066	0.067
Furniture and miscellaneous manufacturing[c)]	159	124	141	0	0.0	0.0		
Total manufacturing	159	124	141	224	19.5	21.1	0.029	0.036
Pro memoria:								
Yen/U.S Dollar exchange rate			121					
Total manufacturing, without additional price data[d)]				217	12.9	13.7		

a) Double deflated PPP; b) PPP based on Gersbach and van Ark (1994) specifiecd price so coverage ratio of 0 percent; c) UVR for total manufacturing
d) Information from MITI survey of intermediate goods prices, hedonic car PPP of van Mulligen (2003)
Sources: see Appendix A

Another important area of price measurement problems is accounting for quality differences, in particular for ICT goods such as computers and for cars. In a growing number of countries these quality improvements are accounted for by using hedonic price indices (Triplett, 1990 and forthcoming). Relatively less effort has been put into measuring quality differences across countries. For computers we make use of a detailed producer-based PPP for personal computers from a study by the McKinsey Global Institute in 1990, which is described by Gersbach and van Ark (1994), and updated by us to 1997 using hedonic producer price indexes for computers in Japan and the United States. Van Mulligen (2003) provides quality-adjusted PPPs for the automobile industry. Americans tend to drive larger and heavier cars so cars produced in the United States will tend to be on average more expensive. Van Mulligen (2003) estimates hedonic regressions to take these differences into account and we therefore use his hedonic PPP for automobiles.

The (Fisher) UVR for total manufacturing of 141 Yen per U.S. dollar is clearly above the exchange rate of 121 yen/dollar, which suggests a 15 percent higher producer price in Japanese manufacturing relative to the United States in 1997. However, large differences exist between the UVRs. For example, the wood products branch has a UVR of 264, while electrical machinery has a UVR of 99. The reliability of our UVR, measured by the coefficient of variation of the UVRs, also differs between branches. Food products, wood products and rubber and plastics all have relatively high coefficients of variation in comparison to other branches like basic metal products. As a result, the 5 percent confidence interval for the food processing (Laspeyres) UVR would be [117,316] while this interval is [118,142] for basic metal products. As no matches could be made for furniture and fixtures and miscellaneous manufacturing, the UVR for total manufacturing was used.

When compared to the exchange rate the UVRs can be seen as an indicator of price competitiveness. In branches where the UVR is above the yen/dollar exchange rate, the U.S. is more competitive on output price. Vice versa, a relatively low price level indicates Japanese competitive strength. Table 3 shows the relative price level, calculated as the UVR divided by the exchange rate. There are three branches where the Fisher UVR is below the exchange rate: rubber and plastics, machinery and equipment and electrical machinery. The low Japanese price level in rubber and plastics can be due to the lack of matches. With only four matches and a high coefficient of variation, the UVR is not very reliable. For the other two branches, however, there are more matches and the coefficient of variation is lower.

Table 3, Prices of manufacturing branches in Japan relative to the United States

U.S.=100, 1997	Laspeyres	Paasche	Fisher
Food and kindred products	178.7	178.7	178.7
Textile mill products	134.7	116.4	125.2
Wearing apparel	153.4	126.7	139.4
Leather products and footwear	244.8	144.3	188.0
Wood products	291.9	159.6	215.9
Paper products, printing and publishing	136.7	117.5	126.7
Chemicals and allied products	151.6	125.8	138.1
Petroleum and coal products	143.5	108.5	124.8
Rubber and plastic products	102.3	87.7	94.7
Non-metallic mineral products	115.8	94.6	104.7
Basic metal products	117.7	97.8	107.3
Fabricated metal products	175.5	121.7	146.1
Machinery and equipment	107.7	76.5	90.8
Transport equipment	117.0	96.9	106.5
Office, accounting and computing machinery	104.9	104.9	104.9
Electrical machinery and instruments	81.9	81.2	81.5
Furniture and miscellaneous manufacturing	131.4	102.8	116.2
Total manufacturing	131.4	102.8	116.2

3.2 Comparative Labour Productivity Performance

Relative strength due to a low relative price level does of course not provide a complete picture of comparative advantage. For that we need to compare productivity in both countries. In this paper we focus on labour productivity defined as value added per person employed and per hour worked based on national accounts estimates of output and employment. For this our main source are the Japanese and U.S. national accounts estimates as provided in the OECD STAN database of National Accounts.[6] In Table 4 we convert Japanese output into U.S. dollars using the unit value ratios described above, and calculate the relative labour productivity level for the manufacturing branches.

Table 4 shows that labour productivity in Japanese manufacturing is substantially below the U.S. level, both in terms of value added per person employed as well as value added per hour worked. Relative productivity on a per hour basis is somewhat higher than on a per person basis, reflecting the higher number of hours worked in the United States (1989 hours per person) than in Japan (1977 hours per person) in 1997.

[6] See Appendix A for more details on the data used. See Appendix C for a comparison using output and employment data from the Census and a reconciliation with the 1987 benchmark comparison as presented in van Ark and Pilat (1993).

As with relative price levels, heterogeneity in comparative productivity levels across industries is considerable. On the one hand, Japanese productivity in petroleum and coal, basic metal products and machinery and equipment is considerably above the level in the United States. Conversely, productivity in Japan in branches like wearing apparel and food products is less than half the U.S. level.

Table 4, Labour productivity of manufacturing branches in Japan relative to the United States (U.S.=100), 1997

	Per person			*Per hour*		
	Japan in US$	U.S. in US$	Relative Japan/U.S.	Japan in US$	U.S. in US$	Relative Japan/U.S.
Food and kindred products	24.5	68.9	35.5	12.9	35.0	36.7
Textile mill products	11.6	37.5	31.1	5.9	19.5	30.5
Wearing apparel	21.1	31.0	68.1	10.8	16.1	67.2
Leather products and footwear	26.2	46.1	56.9	13.4	24.8	54.1
Wood products	12.2	45.0	27.1	5.8	22.8	25.4
Paper products, printing and publishing	49.0	59.6	82.3	24.5	31.0	79.1
Chemicals and allied products	108.6	153.4	70.8	58.7	79.5	73.9
Petroleum and coal products	410.2	215.8	190.1	216.3	107.5	201.2
Rubber and plastic products	58.4	50.3	116.2	29.4	25.5	115.2
Non-metallic mineral products	54.0	62.7	86.0	27.0	30.9	87.2
Basic metal products	111.6	71.1	156.9	55.8	34.8	160.0
Fabricated metal products	32.8	63.5	51.6	16.0	31.1	51.5
Machinery and equipment	76.4	57.9	132.1	37.1	29.4	126.5
Transport equipment	60.2	80.6	74.7	29.2	40.2	72.6
Office, accounting and computing machinery	75.5	125.4	60.2	38.8	63.6	61.0
Electrical machinery and instruments	81.1	81.2	99.9	41.8	41.2	101.5
Furniture and miscellaneous manufacturing	36.6	46.5	78.7	18.7	23.6	79.4
Total manufacturing	52.2	69.3	75.3	26.4	34.8	75.7

Note: Japanese figures converted to U.S. dollars using Fisher UVRs

4. Explaining the labour productivity gap

When focusing on the productivity gap for the manufacturing sector as a whole between Japan and the U.S., individual branches may contribute to this gap in two ways. First, as indicated above, there may be a labour productivity gap in individual branches. Second, employment in the manufacturing sector in Japan can also be more concentrated in branches with below-average productivity levels such as textiles or wood products. One way to distinguish between these factors is through an interspatial shift-share analysis.[7] Let superscripts x and u denote respectively, Japan and the U.S. and let LP stand for labour productivity. The difference in total manufacturing labour productivity can be decomposed as follows:

$$LP^u - LP^x = \sum_{i=1}^{n}\left[\left(LP_i^u - LP_i^x\right)\tfrac{1}{2}\left(S_i^u + S_i^x\right)\right] + \sum_{i=1}^{n}\left[\left(S_i^u - S_i^x\right)\tfrac{1}{2}\left(LP_i^u + LP_i^x\right)\right], \qquad (4)$$

where LP_i is the labour productivity level in branch i and S_i the share in employment of branch i. The first term gives the contribution to the total manufacturing productivity gap of differences in branch labour productivity (within-branch effect) while the second term shows the contribution of differences in employment shares (structure effect).

[7] See Timmer (2000) for an extensive discussion.

Table 5, Decomposing the labour productivity gap in manufacturing between Japan and the U.S., 1997

	Employment share		Contribution to the productivity gap (in percentage points)		
	Japan	U.S.	Within-branch	Structural	Total
Food and kindred products	11.9	9.2	8.1	-2.3	5.8
Textile mill products	5.6	4.3	2.2	-0.6	1.6
Wearing apparel	3.5	3.3	0.7	-0.1	0.6
Leather products and footwear	0.4	0.4	0.2	0.1	0.2
Wood products	2.5	4.7	2.1	1.1	3.2
Paper products, printing and publishing	8.2	11.8	2.3	3.5	5.9
Chemicals and allied products	3.2	5.4	2.8	5.3	8.1
Petroleum and coal products	0.3	0.7	-2.0	2.6	0.6
Rubber and plastic products	1.4	5.2	-0.5	3.7	3.2
Non-metallic mineral products	3.9	3.1	0.4	-0.8	-0.3
Basic metal products	3.9	4.0	-3.1	0.1	-3.0
Fabricated metal products	7.9	8.1	4.2	0.1	4.3
Machinery and equipment	12.0	10.8	-3.7	-1.4	-5.1
Transport equipment	10.3	10.0	3.5	-0.4	3.1
Office, accounting and computing machinery	2.0	1.5	1.3	-0.8	0.6
Electrical machinery and instruments	14.8	12.9	-0.3	-2.8	-3.0
Furniture and miscellaneous manufacturing	8.6	5.1	1.2	-2.5	-1.3
Total manufacturing	100.0	100.0	19.4	4.9	24.2

Note: Contributions have been normalized as productivity figures based on Fisher UVRs are not additive

Table 5 shows employment shares for each manufacturing branch as well as the results of the shift-share decomposition.[8] In this table, a positive number makes a positive contribution to the labour productivity gap of 24.2 percentage points. Conversely a negative number reduces the labour productivity gap. For example, the food products branch accounts for 5.8 percentage points of the total labour productivity gap. This positive contribution can be attributed to lower Japanese productivity in the food products branch, which increases the gap by 8.1 percentage points. However, the employment share of this industry is larger in Japan than in the United States so the structure effect decreases the total contribution of the branch to the productivity gap.

As can be seen from the third column in table 5, differences in branch labour productivity account for about four-fifths of the total labour productivity gap. This means that one-fifth of Japan-US labour productivity gap in manufacturing is due to a larger concentration of U.S. employment in high labour productivity branches than in Japan. Table 5 makes clear that the larger size of the chemical sector (petroleum and oil, chemical products, rubber and plastics) in the U.S. is especially important in this respect, as is the paper, printing and publishing branch.

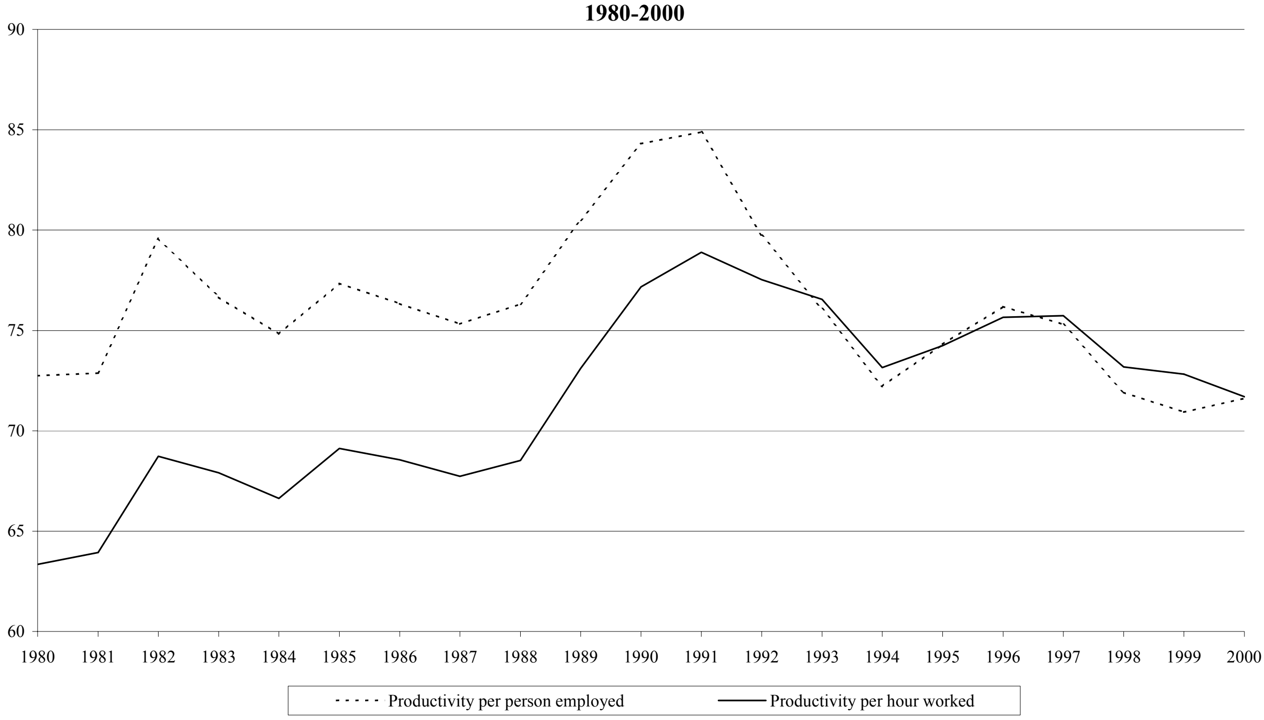
Looking at the contribution of each branch to the total productivity gap, the chemical branch is important, mainly through its structure effect. Food products, computers and fabricated metal products also make a large contribution to the Japan-US manufacturing productivity gap because of the much higher within-branch productivity in the United States, while the reverse is the case for machinery and equipment and basic metal products.

8 Labour productivity levels have been converted to dollars using Fisher UVRs. As these are not additive, branch contributions may not add up to total manufacturing. Therefore the contributions have been normalised.

5. The labour productivity trend from 1980 to 2000

Using time series on real output, employment and hours worked for both countries, the benchmark figures can be extrapolated to calculate labour productivity levels for the period 1980 to 2000. Figure 1 shows Japan's labour productivity level relative to the United States for total manufacturing on per person-basis as well as a per hour-basis over this period.

Figure 1, Japanese labour productivity in manufacturing relative to the United States (U.S.=100) 1980-2000



Until 1991 productivity in Japanese manufacturing was still growing relative to productivity in the United States. Van Ark and Pilat (1993) show that the whole period from 1950-1990 can be characterized by strong catch-up to the U.S. level. Their figures show that in 1950, Japanese productivity in manufacturing stood at less than 20 percent of the level in the United States, while in 1990, this had risen to almost 80 percent. Although our levels for 1990 are somewhat lower (see Appendix C for details) a similar picture emerges. Figure 1 shows that this trend reversed from the 1991 Japanese recession onwards when productivity per hour began to drop from 79 percent to 72 percent of the U.S. level in 2000. Until 1993 workers in Japanese manufacturing worked more hours than their U.S. counterparts, but as hours between Japanese and U.S. workers converged, the per hour-based and per person-based productivity estimates have not been very different since. This development is seen in most branches, so in the remainder we will focus on the development of productivity per hour worked.

Table 6, Productivity per hour in Japanese manufacturing branches relative to the United States (U.S.=100), 1980-2000

	1980	1991	1995	2000
Food and kindred products	45.3	41.2	34.1	42.8
Textile mill products	46.1	32.7	32.4	25.1
Wearing apparel	94.9	100.4	64.3	38.5
Leather products and footwear	47.7	59.2	50.0	40.6
Wood products	22.8	25.4	26.5	20.3
Paper products, printing and publishing	57.9	77.0	78.0	73.7
Chemicals and allied products	48.2	75.7	75.4	77.5
Petroleum and coal products	389.1	248.5	149.2	140.1
Rubber and plastic products	187.9	129.4	122.6	93.1
Non-metallic mineral products	69.4	89.2	86.7	80.8
Basic metal products	162.5	144.7	145.6	140.1
Fabricated metal products	33.4	52.5	51.8	47.3
Machinery and equipment	64.6	139.7	121.7	122.5
Transport equipment	47.7	79.5	74.8	74.4
Office, accounting and computing machinery	61.9	72.6	63.8	47.2
Electrical machinery and instruments	103.1	124.8	109.3	89.5
Furniture and miscellaneous manufacturing	79.9	81.4	74.5	76.5
Total manufacturing	63.3	78.9	74.2	71.7
Pro memoria: Using national ICT deflators				
Office, accounting and computing machinery	2066.8	426.9	153.3	15.2
Electrical machinery and instruments	102.9	118.9	98.9	76.6
Total manufacturing	68.8	82.0	74.8	67.7

In Table 6, we show relative productivity in Japanese manufacturing branches for 1980, 1991, 1995 and 2000. For total manufacturing, we can see how the changes in relative levels reflect the comparative growth rates as presented in Table 1. Until 1991, Japanese growth outpaced U.S. growth, leading to rising productivity levels, but since then Japanese levels have dropped relative to those in the U.S..

It should be stressed that for two manufacturing branches, namely the office, accounting and computing machinery (OCM) branch and the electrical machinery and instruments branch, the growth rates we applied differ from the official national accounts estimate of real value added in Japan. For these branches we applied the U.S. price deflator to Japan for the period 1980-2000. The U.S. is one of the few countries which makes use of hedonic, or constant-quality, price indices for many ICT goods (see e.g. Grimm, Moulton and Wasshausen, 2002). As a result, prices of computers and semiconductors (the latter is part of the electrical machinery branch) show a much more rapid decline than in many other countries. Although prices of ICT goods in Japan also fall rapidly, the national accounts deflators for these branches do not appear to be compatible with those used in the U.S. National Income and Product Accounts. To make a comparison possible, we therefore apply the U.S. deflators for the ICT industries to Japan.[9] The last three lines of Table 6 show the productivity levels of OCM and electrical machinery and instruments if we were to use the Japanese ICT deflators, as well as the impact this would have on the figures for total manufacturing. In particular for OCM the results suggest an implausible development. The differences for electrical machinery and instruments are less pronounced, but here too Japanese productivity comes out more favourably for the last part of the sample period when using U.S. price indices. For total manufacturing our preferred procedure suggests a widening of the productivity gap by about 2.5 percentage points between 1995 and 2000, whereas the gap would have widened by 8 percentage points over only five years when using Japanese ICT deflators.[10]

Looking at other branches we see that in most branches relative labour productivity levels in Japan increased between 1980 and 1991 (12 of the 17 branches) while nearly all branches show declines after 1991 (15 of the 17 branches). This suggests that the declining relative productivity levels cannot be simply explained by booming productivity growth in the U.S. in, for example, the ICT-producing industries. For example, Table 6 also shows precipitous declines of productivity levels in branches such as textiles and leather products. Wearing apparel is the most extreme example with a Japanese productivity level equal to that in the U.S. in 1991 but below 40 percent in 2000. The underlying figures show an absolute decrease in labour productivity of on average 6.7 percent per year in Japan relative to an average annual growth of 4 percent in the United States. Even though Japanese employment in this branch dropped by nearly a third, real output dropped by two-thirds leading to the large drop in productivity levels. Although other branches have suffered less, even branches such as electrical machinery that were characterized by low relative price levels in 1997 show declining relative productivity levels. Hence the widening productivity gap in manufacturing between Japan and the U.S. has been rather pervasive during the 1990s.

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[9] U.S. deflators are not directly applied, but after making a correction for differences in the general inflation level. See Appendix B of van Ark *et al.* (2002) for more details and Schreyer (2000, 2002) for further discussion on this method.

[10] Our aggregate time series for total manufacturing also differ from the original national accounts series because we use a Törnqvist aggregation procedure. See also Appendix A and the additional columns with original national accounts data in appendix tables B3 and B4.

6. Unit Labour Cost

So far we have dealt with price competitiveness and relatively productivity but this reflects only part of a country's competitive position in manufacturing. Labour productivity should also be related with the (labour) cost of production to gauge cost competitiveness. This is commonly done by looking at unit labour cost (ULC), defined as the labour cost of producing a unit of output. To compare ULC across countries, both labour cost and value added need to be in the same currency. Labour cost is converted using the exchange rate, while value added is converted using the appropriate UVRs as before. This is to reflect that the development of the exchange rate has a direct effect on relative cost, but not on relative labour productivity. This leads to the following expression for relative RULC:

$$RULC = \left(\frac{LCH^{x} / ER^{xu}}{LCH^{u}} \right) \left(\frac{LP^{u} / UVR^{xu}}{LP^{x}} \right), \qquad (5)$$

where *LCH* is labour cost per hour and *LP* is productivity per hour (value added per hour worked). In this equation *x* and *u* once again refer to Japan and the United States respectively and all variables are expressed in U.S. dollars. Labour cost is converted at the exchange rate (*ER*) and productivity is converted at the unit value ratio (*UVR*).[11]

To get a good comparison of relative unit labour cost, all components of labour compensation (wage compensation, employee and employer taxes and premiums, and labour compensation for self-employed persons) should be included. We therefore obtain data on total labour compensation of employees from the national accounts in both countries and adjust these to include an imputed wage sum for self-employed persons by assuming that the average wage of self-employed is equal to that of employees. Table 7 shows the results for manufacturing branches and for total manufacturing for the benchmark year 1997.

Overall ULC in Japan was 25.5 percent higher than in the U.S. in 1997. However, this hides a wide range of differences for the individual branches. ULC in Japan's wood industry is more than three times as high as in the U.S., while ULC in the basic metal branch is only 64 percent of the U.S. level.

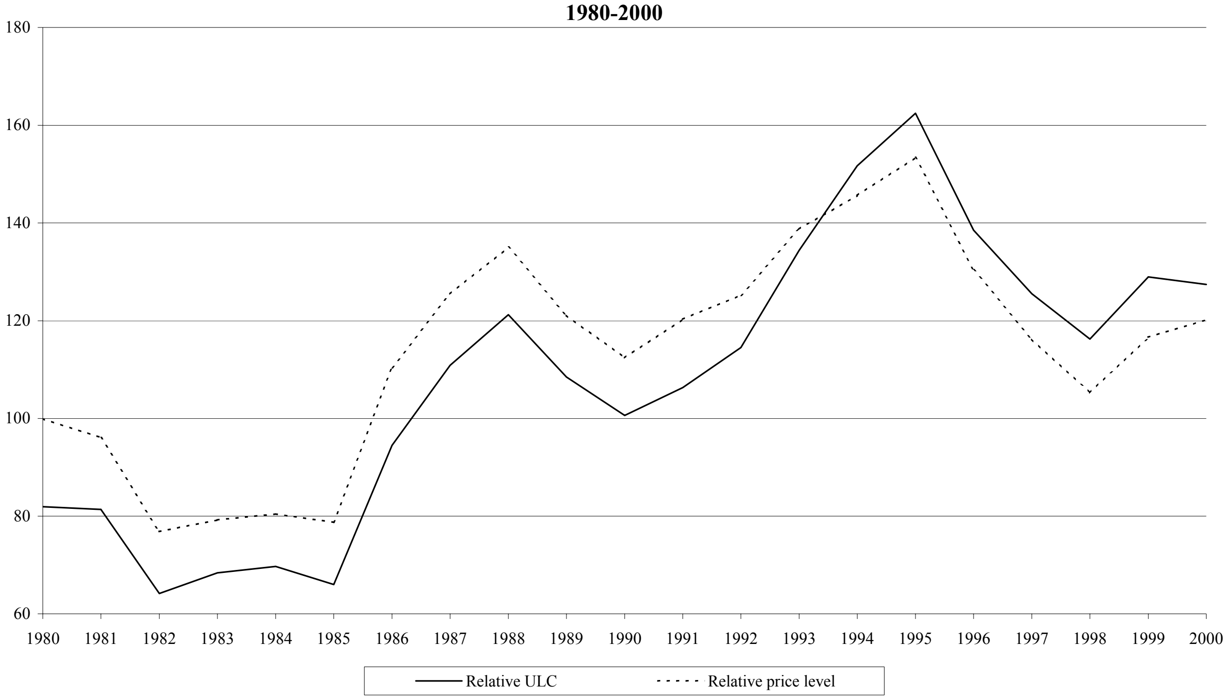
[11] See Stuivenwold and Timmer (2003) for a more detailed exposition of relative unit labour cost.

Table 7, Unit labour cost of manufacturing branches in Japan relative to the United States (U.S.=100), 1997

	Labour cost relative to U.S.	Labour productivity relative to U.S.	Unit labour cost relative to U.S.
Food and kindred products	93.4	36.7	254.4
Textile mill products	79.4	30.5	260.2
Wearing apparel	109.1	67.2	162.3
Leather products and footwear	119.4	54.1	220.6
Wood products	82.2	25.4	324.2
Paper products, printing and publishing	106.1	79.1	134.2
Chemicals and allied products	107.1	73.9	144.9
Petroleum and coal products	130.0	201.2	64.6
Rubber and plastic products	105.1	115.2	91.2
Non-metallic mineral products	112.6	87.2	129.1
Basic metal products	102.9	160.0	64.3
Fabricated metal products	89.0	51.5	172.7
Machinery and equipment	99.9	126.5	79.0
Transport equipment	86.4	72.6	119.1
Office, accounting and computing machinery	82.6	61.0	135.3
Electrical machinery and instruments	85.3	101.5	84.1
Furniture and miscellaneous manufacturing	108.2	79.4	136.2
Total manufacturing	95.1	75.7	125.5

Note: labour cost and labour productivity are both measured in per hour terms

Figure 2, Unit labour cost in total manufacturing in Japan relative to the United States (U.S.=100) 1980-2000



With time series on productivity and labour compensation per hour, a trend can also be extrapolated. Figure 2 shows ULC for the period 1980-2000 as well as the relative price level (defined as the PPP divided by the exchange rate). As the figure shows, ULC in Japanese manufacturing has been higher than in the U.S. since 1987. Under the influence of a strengthening yen and slower productivity growth, Japanese ULC rose to a peak of 162 percent of the U.S. level in 1995. Since then relative ULC declined again, but in 2000 ULC was still nearly 30 percent higher in Japan than in the United States. The overall rising trend in Japanese ULC relative to the U.S. fits the long run picture as described in Pilat and van Ark (1994). They show how in 1955 Japanese ULC was only half the U.S. level and as Figure 2 shows, in 1980 ULC was still 20 percent below the U.S. level.[12]

In Table 8 we look at the factors underlying the rise of Japanese ULC relative to the United States between 1980 and 2000. We split up the average annual change in relative ULC into changes in labour compensation and productivity in Japan and the U.S. as well as changes in the exchange rate.[13] The bottom line of Table 8 shows how Japanese relative ULC grew by more than 2 percent on average per year between 1980 and 1991, before exploding by more than 10 percent per year until 1995. Between 1980 and 1991 Japanese labour cost per hour grew at about the same rate as in the U.S. and the exchange rate appreciated, but faster Japanese productivity growth held overall ULC growth in check.

Table 8, Decomposition of changes in unit labour cost, 1980-2000

	Average change		
	1980-1991	1991-1995	1995-2000
Japanese labour cost per hour	4.6	3.2	1.1
U.S. labour cost per hour	4.9	3.1	3.9
Japanese labour productivity per hour	5.1	2.6	4.1
U.S. labour productivity per hour	3.1	4.1	4.8
Exchange rate	-4.7	-9.0	2.7
Unit labor cost	2.4	10.6	-4.9

The table shows that the major factor contributing to the movements in ULC after 1991 has been exchange rate fluctuations. Between 1991 and 1995 the Yen appreciated by on average 9 percent per year, accounting for nearly the entire annual 10.5 percent rise in relative ULC, but slower productivity growth in Japan contributed as well. After 1995, ULC declined again, which was partly due to a depreciating yen, but also to a strong decline in Japanese wage cost growth. Still, although productivity growth in Japanese manufacturing improved compared to 1991-1995, it continued to linger behind the U.S.

To gauge the competitiveness of Japanese exports, it is probably more important to focus on the development of relative ULC in branches like machinery and equipment, transport equipment and electrical machinery. If the relative ULC in food products rises sharply it is of little consequence since those goods are barely traded with the United States.[14]

The table shows that relative ULC has risen in nearly all manufacturing branches, which shows that decreasing Japanese cost competitiveness is a widespread phenomenon. The exception is the chemical products branch where cost competitiveness increased substantially between 1980 and 2000. There are also branches where despite a worsening position, Japan is still more cost competitive compared to the U.S. such as basic metal and electrical machinery. Especially basic metal products in Japan have remained very cheap compared to the United States. As with labour productivity levels most changes in the ULC level can be seen across all branches, reflecting the importance of exchange rate movements. A more favourable yen/dollar rate has outweighed the widespread U.S. productivity growth advantage after 1995, which is reflected in considerable improvements Japanese cost

[12] As with labour productivity, the ULC level found by Pilat and van Ark (1994) based on the 1987 ICOP benchmark comparison is not the same as the level we find here, but it is roughly comparable.
[13] Changes in relative prices are already accounted for in relative productivity changes.
[14] Food products made up 0.29% of Japanese exports to the U.S. in 1997. The share of motor vehicles on the

competitiveness after 1995 in nearly all branches. Still, as mentioned above, ULC levels in 2000 were still well above those in the U.S. in most branches.

Table 9, Unit labour cost in Japanese manufacturing branches relative to the United States (U.S.=100), 1980-2000

	1980	1991	1995	2000
Food and kindred products	104.2	207.6	357.0	212.6
Textile mill products	111.2	215.2	319.1	317.0
Wearing apparel	74.8	96.3	227.4	285.9
Leather products and footwear	140.4	166.3	321.9	291.5
Wood products	187.7	282.5	390.6	411.5
Paper products, printing and publishing	115.1	126.3	173.8	136.7
Chemicals and allied products	145.9	141.3	190.1	125.6
Petroleum and coal products	12.7	48.1	111.8	91.2
Rubber and plastic products	35.9	66.6	108.2	109.8
Non-metallic mineral products	74.3	102.4	162.2	131.9
Basic metal products	35.8	67.2	87.6	77.5
Fabricated metal products	141.4	157.2	224.5	203.1
Machinery and equipment	82.8	66.9	110.3	76.6
Transport equipment	92.8	93.1	129.1	116.6
Office, accounting and computing machinery	78.9	92.2	165.7	146.3
Electrical machinery and instruments	48.9	60.8	101.5	86.2
Furniture and miscellaneous manufacturing	88.9	116.5	183.8	142.5
Total manufacturing	81.9	106.3	162.4	127.4
Pro memoria: Using national ICT deflators				
Office, accounting and computing machinery	2.4	15.7	68.9	455.4
Electrical machinery and instruments	49.0	63.8	112.2	100.8
Total manufacturing	75.5	102.3	161.2	134.9

In Table 9 we also show the extra lines with the ULC development if we had applied the national ICT deflators to the ICT industries. These deflators would exaggerate the rise in relative Japanese ULC between 1980 and 2000, because of the implausible development of relative ULC in the office, accounting and computing machinery branch as well as the less favourable development of Japanese ULC in the electrical machinery branch. Still the overall picture remains unchanged, namely that Japanese cost competitiveness decreased considerably since 1980.

other hand was 28.7% (OECD Bilateral Trade Database, 2001).

7. Conclusions

In this paper we have studied several measures of competitiveness for the Japanese manufacturing sector relative to the United States over the period 1980-2000. Using industry-specific unit-value ratios (UVRs) we show that labour productivity in Japanese manufacturing lags considerably behind the U.S. in terms of both output per person employed and output per hour worked. For most of the 1990s Japanese manufacturing has fallen further behind the U.S. level. In 2000, value added per hour worked in Japanese manufacturing stood at 72 percent of the U.S. level after peaking at 79 percent in 1991. Underneath this aggregate estimate, there is a wide range of branch-specific labour productivity levels. But in general, Japanese manufacturing branches have not kept up with the strong productivity growth surge in the U.S. after 1995. For example, while in 1995 the electrical machinery branch was still more productive in Japan than in the U.S., in 2000 the U.S. had established a clear lead in this branch. The relative Japanese decline is not only seen in the ICT-producing industries such as computers and electrical machinery but also in such diverse branches as wearing apparel, transport equipment and rubber and plastics.

Japanese manufacturing has also suffered from rising unit labour cost levels. The long-term trend of a strengthening yen has eroded Japanese cost competitiveness in nearly all branches between 1980 and 2000, although ULC levels have declined somewhat from 1995 onwards due to a more favourable exchange rate development and moderate wage growth in Japan. Still in 2000 unit labour cost in Japanese manufacturing was still 27 percent above the U.S. level. In comparison, in 1980 Japanese unit labour cost stood at only 82 percent of the U.S. level.

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Appendix A: Data sources and methods

This Appendix contains documentation on the sources and methods used to construct the data presented in the main text. We first deal with data used to calculate the unit value ratios for products, industries, branches and total manufacturing and then with the construction of data on trends in output, employment and labour compensation.

Product data and Census industry data

The unit value ratios (UVRs) are calculated on the basis of detailed data on sales quantities and values of a large number of products. For the U.S., these data are from the *1997 U.S. Economic Census* and for Japan we use the *Census of Manufacturing 1997, Report by Product*.

Using data for quantities and values from the Census, 215 product matches were made.[15] In Japan the value of shipments in the Census includes excise taxes, which leads to an overstatement of output of goods such as alcoholic drinks and petroleum products. We estimate indirect taxes as a percentage of gross output from the 1995 Input/Output table for Japan and refer to the Drinks industry for beer and Petroleum refinery products and Coal products for gasoline and related products.[16]

In addition to the Censuses of both countries we also use additional information on relative prices. For automobiles we use the hedonic car PPP from van Mulligen (2003). Twelve matches were included using information from a price survey of intermediate goods by the Ministry of International Trade and Industry (MITI). To weigh the MITI matches, output data on these products were matched to the PPP data from the price survey. As these PPPs are based on producer prices, no adjustments had to be made to make them comparable to the rest of the matches. Finally, we include a PPP for computers based on the study of Gersbach and van Ark (1994). As this PPP is for 1987 we had to update it using the movement in relative prices between 1987 and 1997. For Japan we use the producer price index from the Bank of Japan for computers & related accessories. For the United States we apply the output price index for the computer industry used by the U.S. Bureau of Economic analysis in constructing the National Income and Product Accounts. The latter price index is obtained from the detailed tables 'Shipments of Manufacturing Industries'.

UVRs at product level are weighted to arrive at UVRs for industries, branches and total manufacturing. For the U.S., the *Economic Census* presents data for 6-digit NAICS[17] industries (comparable to the former 4-digit SIC87[18] industries). For Japan, the *Census of Manufacturers 1997, Report by Enterprise* provides data for 4-digit JSIC[19] industries. For the U.S. these data cover all establishments while for Japan only establishments with four or more employees are used. Since these data are only used to weight the industries in calculating branch PPPs, the omission of smaller establishments is unlikely to bias the results in any substantial way. To aggregate branch PPPs to a total manufacturing PPP we used gross output data from the National Accounts. This procedure could not be followed at the more detailed level due to insufficient detail in the National Accounts.

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[15] For Japan a 'product' refers to one or more 6-digit items, for the U.S. it refers to one or more 10-digit (NAICS) items.
[16] We used the 1995 I/O table since this contained more detailed industries than the 1997 I/O table from the OECD.
[17] North American Industrial Classification System
[18] Standard Industrial Classification, 1987
[19] Japanese Standard Industrial Classification

Trends for output, employment and hours

For value added in current prices, implicit deflators for value added, and the total number of persons employed we mainly use information from the new OECD STAN Database. This database uses the national accounts of the two countries as its main source. However, to achieve the necessary detail and correspondence to ISIC rev3,[20] we also use several secondary data sources. Hence apart from STAN we also use the *Annual Survey of Manufacturers* and the *NBER Manufacturing Industry Database* for the U.S. and the OECD *Structural Statistics for Industry and Services*, to break down the OECD STAN tables into more detailed industries. For Japan, the data in STAN cover all years up to 1998. At the time of writing, the data for Japan in STAN are still based on the old SNA68. We use data directly from the Japanese national accounts tables on an SNA93 basis to include 1999 and 2000 in the database.

The database on value added and the number of persons employed is described in detail in van Ark *et al.* (2002), where 27 manufacturing industries are distinguished. Since we only compute UVRs for 17 industries, some industries are combined. This was most noticeable for electrical machinery and instruments (ISIC 31-33), where seven separate industries are distinguished, including for example semiconductors (ISIC 321) and insulated wire (ISIC 313). Other industries that are built up from more detailed information are paper, printing and publishing (originally two industries) and transport equipment, where originally four industries are distinguished. To aggregate the deflators, we use a Törnqvist index number formula to achieve more consistency across countries. Our data for total manufacturing are also aggregated from the detailed 27 industries using a Törnqvist index. This aggregation method means that our trends for total manufacturing will differ from those in the National Accounts. While the U.S. also uses a chain-weighted index in the National Income and Product Accounts, their aggregation takes place at a more detailed level. The statistical office in Japan uses a fixed-weight Laspeyres index in its SNA68 National Accounts, which means our total manufacturing figure will differ even more, but the methodology is as consistent as possible across both countries, so the results can be better compared. For comparison we show the figures from the National Accounts in the detailed data tables of Appendix B.

Another reason for differences between our trend for manufacturing and those from the National Accounts is the difference in deflation of ICT industries. It is well known that those industries, which include computers and semiconductors, have shown rapid quality improvements over the past decades. The U.S. is one of the few countries where constant-quality price indices are used to deflate most ICT goods. These hedonic price indices show rapid price declines in the case of computers and semiconductors since the cost of computing power has decreased with increasing quality of these goods. We also apply these U.S. deflators to Japanese ICT industries (after correcting for differences in the general level of inflation).[21] The reason is that using national deflators would almost certainly underestimate price declines in these industries. The pro-memoria lines in Tables 6 and 9 confirm that using national deflators would lead to a development of relative productivity that would be hard to justify.

For the number of hour worked per person, we relied on the ICOP Industry Database for total manufacturing.[22] Data for the Japanese manufacturing branches are based on the number of monthly

[20] International Standard Industrial Classification, revision 3.
[21] The general inflation level is defined here as the change of the deflator of GDP, excluding the ICT industries.

hours worked from the Monthly Labour Survey of the Ministry of Health, Labour and Welfare. For the U.S. data for the manufacturing branches are from the Current Employment Statistics (CES) of the U.S. Bureau of Labour Statistics (BLS) and the BLS Hours at Work Survey for 2000. From the CES we take the average weekly hours paid (of production workers) and we use the data from the Hours at Work Survey to adjust these to the average number of hours worked.

Data on labour compensation were also taken from the OECD STAN Database. For the computer industry these data were not available directly from STAN so we used additional data from Censuses to separately distinguish this industry. As labour compensation only refers to compensation of employees, we had to make an adjustment to include compensation for the self-employed as well. Here we assume that the average wage of self-employed is equal to that of employees. This imputation causes an overestimation of labour income in branches where employee income is already a large part of value added. In our dataset this occurs in three Japanese branches namely textiles, wearing apparel and wood products. In the case of textile products, even labour compensation of employees already exceeds value added for a number of years. While this means negative capital income, this is not entirely inconsistent with declining branches in a stagnating economy.

Legend

Industry	*ISIC rev3*	*Acronomym*
Food and kindred products	15-16	FOOD
Textile mill products	17	TEXT
Wearing apparel	18	WEAR
Leather products and footwear	19	LEAT
Wood products	20	WOOD
Paper products, printing and publishing	21-22	PAPE
Chemicals and allied products	24	CHEM
Petroleum and coal products	23	PETR
Rubber and plastic products	25	RUBB
Non-metallic mineral products	26	NONM
Basic metal products	27	BASI
Fabricated metal products	28	FABR
Machinery and equipment	29	MACH
Transport equipment	34-35	TRAN
Office, accounting and computing machinery	30	COMP
Electrical machinery and instruments	31-33	ELEC
Furniture and miscellaneous manufacturing	36-37	MISC
Total manufacturing	15-37	TOT

Appendix B: Trends in productivity in Japan and the U.S., 1980-2000

Table B1, Value added in current prices in manufacturing in Japan, 1980-2000, Billions of Yen

	FOOD	TEXT	WEAR	LEAT	WOOD	PAPE	CHEM	PETR	RUBB	NONM	BASI	FABR	MACH	TRAN	COMP	ELEC	MISC	TOT
1980	5632	2420	1313	150	1182	4598	5123	717	973	2608	8515	3156	7238	7368	948	7561	3617	63121
1981	5949	2458	1453	204	1041	4986	5357	1217	1014	2828	7109	3498	8395	7715	1063	8567	3957	66812
1982	6760	2448	1425	235	1041	5507	5695	1616	992	2839	6703	3642	8983	7633	1220	9183	4130	70051
1983	7380	2438	1545	273	1058	5731	6079	1912	1057	3049	5589	3669	9010	7989	1543	10174	4558	73053
1984	7307	2391	1546	298	1014	5844	6608	1819	1091	3151	7384	3857	9991	8368	1809	12221	4996	79693
1985	7531	2405	1702	359	1093	5997	6636	1899	1166	3264	7419	4451	11395	8969	2158	12697	5347	84487
1986	8009	2376	1974	370	1142	6682	7267	2167	1170	3349	6586	4817	10864	8342	2216	12927	5586	85845
1987	8000	2404	2131	386	1230	6968	7621	1933	1242	3519	7019	4788	10346	8871	2206	13008	5896	87567
1988	7837	2486	2148	377	1284	7410	7948	1616	1257	3816	8233	5250	11922	9072	2377	14394	6144	93569
1989	7935	2212	2257	337	1220	7786	8703	1672	1255	3957	8778	5632	13200	10286	2729	16145	6662	100760
1990	8466	2310	2525	441	1419	8434	8749	1625	1426	4065	8725	6731	15009	10953	3025	17353	6966	108220
1991	9246	2286	2832	482	1439	8949	9028	2404	1479	4174	9104	7398	16516	11196	3248	18608	7427	115820
1992	9741	2364	2689	477	1357	8781	9405	2515	1497	4224	8769	7434	15601	11465	3075	17031	7366	113790
1993	9767	2214	2477	426	1325	8872	9148	2428	1404	4012	7872	7241	13537	11317	2669	16076	7104	107890
1994	9529	1886	2115	397	1234	8812	8944	2574	1343	3991	7379	6472	12496	10860	2516	16139	6868	103550
1995	9508	1658	2047	368	1234	8861	9205	2192	1316	3887	7810	6518	13456	11045	2698	16810	6630	105240
1996	9484	1433	1974	342	1173	9383	9283	2222	1319	3972	7886	6679	13988	11411	3018	17519	6671	107760
1997	9732	1476	1890	322	1109	9132	9257	2725	1386	3896	8374	6598	14499	11478	2874	18068	6647	109460
1998	9742	1299	1668	287	982	8841	8553	2763	1300	3454	6760	5891	13144	10919	2794	16582	6222	101200
1999	9928	1172	1461	264	914	8249	8926	2725	1245	3246	6432	5447	11847	10846	2575	17075	5960	98312
2000	9809	1144	1324	249	873	8365	8458	2872	1246	3317	6814	5446	12103	10413	2331	18647	6189	99599
Average annual growth rates																		
1980-1991	4.5	-0.5	7.0	10.6	1.8	6.1	5.2	11.0	3.8	4.3	0.6	7.7	7.5	3.8	11.2	8.2	6.5	5.5
1991-1995	0.7	-8.0	-8.1	-6.8	-3.8	-0.2	0.5	-2.3	-2.9	-1.8	-3.8	-3.2	-5.1	-0.3	-4.6	-2.5	-2.8	-2.4
1995-2000	0.6	-7.4	-8.7	-7.8	-6.9	-1.2	-1.7	5.4	-1.1	-3.2	-2.7	-3.6	-2.1	-1.2	-2.9	2.1	-1.4	-1.1

Note: For legend, see start of Appendix B

Table B2, Value added in current prices in manufacturing in the United States, 1980-2000, Millions of U.S. dollars

	FOOD	TEXT	WEAR	LEAT	WOOD	PAPE	CHEM	PETR	RUBB	NONM	BASI	FABR	MACH	TRAN	COMP	ELEC	MISC	TOT
1980	51095	16926	14865	4150	18866	54474	46629	18607	16147	17661	43144	44680	64870	51388	17578	67727	17718	566525
1981	56035	17685	16170	4423	17266	58956	55038	20510	18769	17477	48645	48569	73332	59904	20216	76857	20409	630261
1982	62887	17147	16213	4254	16322	63897	56022	17864	19178	15362	35922	45976	62104	70937	22694	80785	20447	628011
1983	65298	19994	17074	4116	20957	68938	60958	18513	21479	18335	29932	47098	57358	82747	22918	90289	21408	667412
1984	66957	20856	17520	3938	23612	77683	64292	16302	24110	21207	36893	54734	66542	103025	27353	105036	25787	755847
1985	71021	20735	17451	3813	23924	84337	66149	17489	25442	22569	31644	57999	66785	103048	24684	111807	27212	776109
1986	74630	22694	18407	3377	26730	90472	69220	17500	26464	24823	32913	59052	63762	108003	25131	107912	27757	798847
1987	77579	23785	18640	3879	31589	97462	81616	20704	28800	22583	33125	61431	70465	111714	29066	115914	29712	858064
1988	84101	24728	19277	4330	32406	107651	92829	30687	29766	23012	41607	66076	82645	112363	31082	132605	32321	947486
1989	88301	26360	19168	4581	33143	114094	100261	28249	32762	24389	43730	67100	89027	107305	32387	138521	34311	983689
1990	96430	26645	19824	4661	31503	114969	106213	29758	32939	24502	41549	67925	90652	105396	30844	145977	34640	1004427
1991	101651	27217	20326	4804	29610	116372	109679	26524	34811	22980	38145	65750	88193	105350	27418	149612	34182	1002624
1992	104189	30238	21856	4852	31482	121054	114588	25789	37321	25343	37741	67904	86621	114164	26671	153641	35275	1038729
1993	103972	30816	21512	4611	34826	121806	117855	28761	40457	25482	41189	71650	92171	129409	26733	157436	38014	1086700
1994	107727	31823	21243	4904	38844	129820	133656	27223	43609	29352	45676	81375	101698	141924	28584	169755	40132	1177345
1995	119794	30346	20633	5206	41313	135852	145665	26980	44740	31302	51074	85233	106523	142940	29970	182893	41131	1241595
1996	117067	31143	20036	4114	38755	140111	147740	28428	48238	32021	48871	91140	111139	140525	32733	191237	43327	1266625
1997	121344	30184	20978	4243	40096	140870	159715	29559	50568	36005	50572	95564	114936	148751	35374	203806	46759	1329324
1998	119220	30127	20527	3991	40777	147076	159909	31097	55247	37437	51125	99567	118476	166458	40275	207499	48925	1377733
1999	136391	29193	19257	3347	42874	157844	161821	28644	57090	40071	48455	104788	112246	180919	35562	214659	53403	1426564
2000	122366	29004	18388	3630	40894	162251	163375	36622	57626	39152	48182	107454	119744	183059	32794	236318	57196	1458055
Average annual growth rates																		
1980-1991	6.3	4.3	2.8	1.3	4.1	6.9	7.8	3.2	7.0	2.4	-1.1	3.5	2.8	6.5	4.0	7.2	6.0	5.2
1991-1995	4.1	2.7	0.4	2.0	8.3	3.9	7.1	0.4	6.3	7.7	7.3	6.5	4.7	7.6	2.2	5.0	4.6	5.3
1995-2000	0.4	-0.9	-2.3	-7.2	-0.2	3.6	2.3	6.1	5.1	4.5	-1.2	4.6	2.3	4.9	1.8	5.1	6.6	3.2

Note: For legend, see start of Appendix B

Table B3, Value added in constant 1995 prices in manufacturing in Japan, 1980-2000, Billions of Yen

	FOOD	TEXT	WEAR	LEAT	WOOD	PAPE	CHEM	PETR	RUBB	NONM	BASI	FABR	MACH	TRAN	COMP *USICT*	ELEC *USICT*	MISC	TOT *USICT*	COMP *JPICT*	ELEC *JPICT*	TOT *JPICT*	TOT *NA*
1980	8618	2177	2824	292	1539	5972	3188	2702	998	2798	7345	3334	7726	7508	27	3016	4221	54883	381	3325	59135	67321
1981	8950	2202	2925	388	1610	6274	3605	3089	975	2877	6087	3583	8628	7620	39	3691	4366	57756	418	3695	61234	69710
1982	9382	2125	2912	425	1557	6856	4056	3193	896	2832	5860	3828	9073	7161	51	4030	4595	59852	503	4161	63636	72003
1983	9740	2166	2930	484	1565	7060	4360	2926	943	2980	5271	3961	9186	7536	89	4553	4991	62674	671	4861	66587	74230
1984	9392	2040	2929	516	1566	7124	4943	3045	932	3040	6563	4007	10125	7910	128	6120	5301	69184	800	5941	72199	79090
1985	9454	2104	2833	550	1569	7253	5368	3171	974	3407	6541	4580	11762	8625	201	7269	5740	75862	1109	7063	78938	85455
1986	9070	2013	2876	537	1524	7609	5941	2137	964	3266	5841	4897	11350	8654	252	7889	5799	76192	1203	7523	78757	84126
1987	8680	2083	2945	540	1429	7922	6234	2667	1100	3438	6386	4955	11123	9459	347	8488	6319	80241	1294	8097	82432	88039
1988	8778	2022	3159	505	1527	8427	6662	2348	1200	3715	7025	5323	12910	9882	453	9991	6650	87301	1534	9780	89815	95086
1989	8748	1761	3393	437	1441	8666	7423	2518	1219	3865	7390	5460	14159	10427	597	11406	7154	93365	1826	11343	96026	101321
1990	9122	1940	3314	490	1560	9407	7819	2432	1357	3958	7564	6034	15436	11069	791	12856	7385	100464	2116	12665	102802	108222
1991	9354	1835	3571	494	1584	9674	8158	2504	1410	3875	7565	6238	16585	11340	1008	13838	7368	104739	2463	14565	108041	113917
1992	9426	1929	3142	482	1533	9199	8979	2701	1411	3952	7495	6220	15316	11204	1247	13288	7124	103530	2461	13951	106128	112331
1993	9238	1944	2613	407	1378	8976	9146	2386	1318	3769	7016	6420	13115	11163	1519	13241	6977	100065	2251	13767	101668	107884
1994	9120	1762	2172	386	1238	8776	9132	2423	1287	3892	7296	6193	12292	10563	1831	14162	6786	99100	2283	14759	100300	107121
1995	9508	1658	2047	368	1234	8861	9205	2192	1316	3887	7810	6518	13456	11045	2698	16810	6630	105240	2698	16810	105240	112985
1996	9405	1404	2125	351	1167	9370	9825	2673	1293	4078	8114	6661	13784	10826	5051	18191	6854	110578	3364	19330	110455	119900
1997	9230	1430	2032	336	1044	9082	10059	2814	1324	4061	8801	6558	14290	10531	8500	19740	7167	114433	3535	21818	113585	124775
1998	9263	1272	1673	300	918	8807	9723	2413	1207	3661	7244	5828	12931	9602	14714	19734	6858	108608	3588	20798	105435	116400
1999	8890	1168	1404	265	832	8109	10383	2294	1177	3451	7114	5523	12156	10656	23358	23027	6785	111149	3699	23669	106204	118375
2000	8281	1160	1219	240	773	8116	10059	2333	1200	3536	7770	5658	12935	11319	27699	29893	7260	118663	3702	28262	111218	124996
Average annual growth rates																						
1980-1991	0.7	-1.6	2.1	4.8	0.3	4.4	8.5	-0.7	3.1	3.0	0.3	5.7	6.9	3.7	32.8	13.9	5.1	5.9	17.0	13.4	5.5	4.8
1991-1995	0.4	-2.5	-13.9	-7.4	-6.2	-2.2	3.0	-3.3	-1.7	0.1	0.8	1.1	-5.2	-0.7	24.6	4.9	-2.6	0.1	2.3	3.6	-0.7	-0.2
1995-2000	-2.8	-7.1	-10.4	-8.5	-9.4	-1.8	1.8	1.2	-1.8	-1.9	-0.1	-2.8	-0.8	0.5	46.6	11.5	1.8	2.4	6.3	10.4	1.1	2.0

Note: For legend, see start of Appendix B; *USICT:* U.S. deflators are used for deflation ICT industries; *JPICT:* pro-memoria, national deflators are used for deflation of ICT industries;
NA : pro-memoria, value added at constant 1990 prices from National Accounts (see ICOP Industry Database)

Table B4, Value added in constant 1995 prices in manufacturing in the United States, 1980-2000, Millions of U.S. dollars

	FOOD	TEXT	WEAR	LEAT	WOOD	PAPE	CHEM	PETR	RUBB	NONM	BASI	FABR	MACH	TRAN	COMP	ELEC	MISC	TOT	TOT *NA*
1980	94770	20745	19482	6244	33257	124734	81633	10644	17471	25748	61940	63946	133280	143390	720	43259	26598	773244	749473
1981	94030	20228	19535	6271	30612	124973	87183	19088	19537	23910	64285	64654	121681	130325	987	48873	29093	799945	783268
1982	100076	19303	18029	5848	29954	125958	87092	15761	18648	19798	47082	57701	70805	106833	1185	47870	27364	711692	737601
1983	101099	22268	19121	5595	34927	132281	95514	21931	20313	23129	39091	60168	57359	112073	1636	53946	28417	746863	782596
1984	97737	23034	19740	5367	39661	138273	96375	23969	22960	25431	46219	67908	89885	139476	2313	68312	34101	868730	866111
1985	103519	22901	19543	5061	40931	142548	97298	27385	24843	26200	41618	69832	86184	146016	2708	79425	34912	907114	889568
1986	99548	23988	20033	4452	44131	143837	102755	19025	24842	27165	44738	68415	84711	147171	3355	80900	33927	914546	876388
1987	100520	24916	20733	5031	50206	148920	119570	29182	28227	25382	43696	72660	85488	154641	5175	89309	36347	989054	953442
1988	107674	24961	21420	5129	49363	154071	120352	30958	29835	26434	46455	77234	101144	158146	6500	103719	38786	1060326	1020767
1989	100927	26473	20588	5236	47057	152916	121248	28568	32791	27973	44979	74098	104165	145718	7667	107522	39496	1055528	1012895
1990	99921	26447	20724	5125	44792	149448	129059	23038	32331	28062	44945	71489	100709	138513	8658	115369	38268	1051888	1004435
1991	99104	26476	20475	5147	40984	146106	127092	20149	33379	25596	44107	66454	92874	127013	9141	117694	36106	1018533	971670
1992	96857	28812	21514	5123	39269	146352	130623	21156	36118	28220	44958	67836	88300	126390	11502	123209	36460	1038864	988714
1993	98964	29699	20867	4790	36665	145456	129958	21664	39199	27753	49932	71173	91621	135713	15903	128698	38692	1077755	1023241
1994	101677	31951	20582	5030	38608	148240	143145	22097	42704	30494	51967	81148	100651	142745	21352	145825	39948	1162580	1098908
1995	119794	30346	20633	5206	41313	135852	145665	26980	44740	31302	51074	85233	106523	142940	29970	182893	41131	1241595	1170705
1996	107371	29756	19492	4122	39657	138792	151201	30332	47283	31629	52336	87466	105435	133770	53821	211113	41505	1277419	1199234
1997	106135	27956	20341	4170	39271	139158	161625	25717	50650	34946	54199	90308	107116	140756	101600	243441	43856	1354421	1264116
1998	99549	26971	19380	3781	39829	136447	152745	26567	52964	34910	56081	90623	106333	154528	202224	283961	44611	1411901	1316101
1999	98605	25789	17402	3163	40600	141336	158044	35412	54889	35654	58689	91702	97690	161809	297043	332043	47664	1484643	1379523
2000	90695	27028	16843	3561	41534	138310	160250	30077	58360	35457	57762	96475	106241	162085	343774	431410	51705	1559751	1444677
Average annual growth rates																			
1980-1991	0.4	2.2	0.5	-1.8	1.9	1.4	4.0	5.8	5.9	-0.1	-3.1	0.3	-3.3	-1.1	23.1	9.1	2.8	2.5	2.4
1991-1995	4.7	3.4	0.2	0.3	0.2	-1.8	3.4	7.3	7.3	5.0	3.7	6.2	3.4	3.0	29.7	11.0	3.3	5.0	4.7
1995-2000	-5.6	-2.3	-4.1	-7.6	0.1	0.4	1.9	2.2	5.3	2.5	2.5	2.5	-0.1	2.5	48.8	17.2	4.6	4.6	4.2

Note: For legend, see start of Appendix B; *NA:* pro-memoria, value added at constant 1990 prices from National Accounts (see ICOP Industry Database)

Table B5, Persons employed in manufacturing in Japan, 1980-2000, 1000s

	FOOD	TEXT	WEAR	LEAT	WOOD	PAPE	CHEM	PETR	RUBB	NONM	BASI	FABR	MACH	TRAN	COMP	ELEC	MISC	TOT
1980	1383	1220	825	83	537	927	485	67	183	698	588	1166	1488	1418	174	1810	1005	14057
1981	1437	1275	738	82	488	997	461	62	202	637	611	1131	1499	1405	178	1930	1069	14203
1982	1434	1257	750	81	457	988	469	59	208	631	625	1078	1460	1413	187	1940	1095	14130
1983	1417	1281	762	78	418	988	462	55	191	563	647	1075	1518	1398	225	2052	1230	14359
1984	1451	1228	733	75	418	1010	484	52	218	622	672	1063	1552	1427	262	2245	1144	14653
1985	1570	1201	739	72	388	984	478	48	223	608	665	1061	1601	1431	299	2267	1144	14779
1986	1470	1193	749	73	391	1029	468	45	222	585	646	1060	1602	1396	296	2335	1145	14703
1987	1522	1129	718	71	395	1052	457	42	217	584	622	1055	1542	1391	298	2276	1168	14537
1988	1575	1110	706	70	406	1103	471	43	223	602	606	1107	1623	1356	298	2322	1232	14853
1989	1583	1115	721	73	399	1106	472	42	225	600	619	1143	1679	1419	318	2406	1251	15170
1990	1596	1106	737	72	397	1130	486	43	231	603	621	1175	1752	1456	331	2408	1271	15415
1991	1660	1085	746	77	400	1188	512	45	244	628	630	1206	1822	1504	336	2482	1343	15908
1992	1693	1115	768	72	389	1194	522	45	239	612	644	1227	1855	1537	351	2507	1315	16085
1993	1740	1024	720	66	382	1206	530	47	232	603	631	1214	1784	1519	338	2407	1301	15744
1994	1810	951	654	70	377	1218	539	48	215	622	608	1153	1688	1487	308	2323	1350	15421
1995	1808	915	613	62	359	1210	507	45	215	590	589	1138	1671	1457	296	2259	1302	15036
1996	1824	860	562	59	355	1209	501	44	207	571	587	1142	1716	1468	298	2261	1282	14946
1997	1838	836	531	54	348	1215	510	44	207	570	578	1138	1727	1480	300	2257	1291	14924
1998	1738	777	543	52	326	1150	500	44	202	557	557	1088	1666	1440	293	2176	1234	14343
1999	1700	751	501	50	316	1129	483	42	204	545	543	1063	1626	1404	288	2120	1172	13937
2000	1698	750	501	50	316	1128	482	42	204	544	542	1062	1624	1402	288	2117	1170	13920
Average annual growth rates																		
1980-1991	1.7	-1.1	-0.9	-0.7	-2.7	2.3	0.5	-3.6	2.6	-1.0	0.6	0.3	1.8	0.5	6.0	2.9	2.6	1.1
1991-1995	2.1	-4.2	-4.9	-5.4	-2.7	0.5	-0.2	0.0	-3.2	-1.6	-1.7	-1.5	-2.2	-0.8	-3.2	-2.3	-0.8	-1.4
1995-2000	-1.3	-4.0	-4.0	-4.5	-2.6	-1.4	-1.0	-1.5	-1.1	-1.6	-1.7	-1.4	-0.6	-0.8	-0.5	-1.3	-2.1	-1.5

Note: For legend, see start of Appendix B

Table B6, Persons employed in manufacturing in the United States, 1980-2000, 1000s

	FOOD	TEXT	WEAR	LEAT	WOOD	PAPE	CHEM	PETR	RUBB	NONM	BASI	FABR	MACH	TRAN	COMP	ELEC	MISC	TOT
1980	1810	992	1164	244	804	2042	1121	198	733	685	1154	1633	2231	1913	417	2704	943	20788
1981	1784	976	1134	252	769	2062	1119	205	746	658	1132	1611	2215	1914	423	2746	940	20686
1982	1744	909	1039	231	682	2054	1091	193	696	590	933	1449	1936	1756	448	2659	884	19294
1983	1707	904	1041	216	731	2092	1054	187	716	591	836	1389	1727	1752	464	2617	901	18925
1984	1696	945	1040	198	779	2167	1055	179	791	620	865	1488	1838	1908	471	2868	957	19865
1985	1688	903	960	174	771	2207	1050	172	791	609	812	1496	1818	1992	447	2893	939	19722
1986	1708	916	933	157	780	2239	1028	164	797	603	754	1450	1730	2031	397	2804	948	19439
1987	1720	926	940	152	834	2270	1030	162	860	574	742	1426	1803	2032	369	2673	960	19473
1988	1718	927	930	152	854	2364	1065	158	874	591	772	1452	1876	2051	375	2712	996	19867
1989	1718	931	918	149	847	2378	1079	155	895	586	778	1465	1926	2062	351	2675	1006	19919
1990	1736	902	883	141	830	2397	1094	157	895	575	760	1442	1898	2018	332	2596	976	19632
1991	1745	869	858	129	767	2349	1090	158	869	540	728	1376	1824	1906	307	2505	928	18948
1992	1727	887	833	124	775	2306	1087	155	882	531	695	1349	1729	1847	281	2430	933	18571
1993	1748	885	827	125	813	2338	1079	150	918	534	682	1364	1750	1771	272	2393	966	18615
1994	1746	915	791	121	853	2362	1058	147	964	550	697	1415	1832	1760	263	2391	986	18851
1995	1746	883	763	112	880	2376	1044	143	984	558	710	1465	1920	1794	271	2392	981	19022
1996	1748	858	687	106	875	2339	1037	139	987	575	711	1474	1960	1795	280	2426	984	18981
1997	1760	805	676	92	891	2365	1041	137	1006	574	711	1505	1986	1846	282	2509	1005	19191
1998	1759	777	625	88	919	2373	1045	136	1025	577	716	1538	2037	1913	284	2520	1015	19347
1999	1756	746	547	83	930	2339	1040	132	1018	583	703	1538	1982	1904	247	2479	1025	19052
2000	1749	710	490	77	921	2309	1043	126	1021	591	702	1558	1983	1865	223	2507	1032	18907
Average annual growth rates																		
1980-1991	-0.3	-1.2	-2.8	-5.8	-0.4	1.3	-0.3	-2.1	1.5	-2.2	-4.2	-1.6	-1.8	0.0	-2.8	-0.7	-0.1	-0.8
1991-1995	0.0	0.4	-2.9	-3.5	3.4	0.3	-1.1	-2.5	3.1	0.8	-0.6	1.6	1.3	-1.5	-3.1	-1.2	1.4	0.1
1995-2000	0.0	-4.4	-8.9	-7.5	0.9	-0.6	0.0	-2.5	0.7	1.1	-0.2	1.2	0.6	0.8	-3.9	0.9	1.0	-0.1

Note: For legend, see start of Appendix B

Table B7, Average number of hours worked per person in manufacturing in Japan, 1980-2000, number

	FOOD	TEXT	WEAR	LEAT	WOOD	PAPE	CHEM	PETR	RUBB	NONM	BASI	FABR	MACH	TRAN	COMP	ELEC	MISC	TOT
1980	2135	2159	2133	2144	2275	2180	1990	2076	2129	2159	2124	2221	2187	2231	2136	2113	2170	2152
1981	2122	2152	2135	2127	2233	2153	1979	2055	2079	2138	2109	2188	2181	2204	2131	2099	2168	2137
1982	2131	2143	2139	2134	2258	2166	1977	2061	2063	2147	2112	2196	2185	2159	2109	2085	2174	2131
1983	2119	2124	2147	2112	2270	2181	1971	2040	2077	2143	2101	2196	2174	2165	2135	2111	2186	2134
1984	2110	2134	2158	2133	2287	2192	1989	2059	2144	2164	2135	2212	2212	2206	2153	2129	2191	2155
1985	2114	2144	2149	2123	2321	2203	2002	2032	2134	2158	2132	2207	2209	2223	2115	2108	2172	2148
1986	2109	2144	2150	2110	2322	2204	2001	2034	2118	2158	2111	2211	2179	2165	2111	2095	2149	2135
1987	2119	2156	2155	2120	2354	2205	2011	2021	2134	2163	2110	2217	2195	2175	2128	2099	2156	2144
1988	2104	2176	2151	2179	2342	2201	1990	2023	2168	2199	2162	2242	2223	2251	2139	2118	2175	2167
1989	2069	2135	2120	2146	2324	2153	1973	2025	2145	2191	2154	2226	2202	2264	2097	2086	2145	2142
1990	2013	2080	2075	2092	2276	2119	1960	2003	2115	2158	2157	2192	2164	2229	2080	2067	2101	2112
1991	1969	2034	2030	2048	2232	2084	1927	1972	2071	2110	2103	2143	2116	2166	2035	2024	2057	2065
1992	1909	1970	1968	1986	2168	2029	1876	1923	2010	2044	2032	2074	2051	2084	1973	1963	1995	2001
1993	1869	1929	1928	1946	2128	1997	1846	1894	1970	2001	1983	2029	2008	2027	1933	1924	1956	1959
1994	1875	1933	1933	1952	2138	2013	1860	1911	1977	2005	1982	2032	2013	2018	1939	1931	1963	1963
1995	1889	1947	1948	1968	2159	2038	1883	1937	1994	2019	1990	2046	2028	2019	1954	1947	1979	1977
1996	1928	1987	1988	1985	2159	2034	1876	1936	1991	2019	1990	2077	2061	2041	1949	1949	1977	1989
1997	1905	1959	1951	1954	2108	2001	1850	1897	1988	2002	2001	2045	2058	2061	1943	1941	1954	1977
1998	1885	1899	1902	1934	2037	1973	1841	1891	1950	1965	1940	1993	1985	2002	1906	1900	1907	1935
1999	1860	1952	1899	1951	2086	1990	1853	1846	1968	1987	1928	1975	1956	1988	1909	1919	1927	1933
2000	1882	1949	1880	1963	2089	2005	1866	1884	1990	2009	1989	1993	2014	2024	1950	1958	1964	1963
Average annual growth rates																		
1980-1991	-0.7	-0.5	-0.4	-0.4	-0.2	-0.4	-0.3	-0.5	-0.2	-0.2	-0.1	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5	-0.4
1991-1995	-1.0	-1.1	-1.0	-1.0	-0.8	-0.6	-0.6	-0.4	-0.9	-1.1	-1.4	-1.2	-1.1	-1.8	-1.0	-1.0	-1.0	-1.1
1995-2000	-0.1	0.0	-0.7	-0.1	-0.7	-0.3	-0.2	-0.6	0.0	-0.1	0.0	-0.5	-0.1	0.0	0.0	0.1	-0.2	-0.1

Note: For legend, see start of Appendix B

Table B8, Average number of hours worked per person in manufacturing in the United States, 1980-2000, number

	FOOD	TEXT	WEAR	LEAT	WOOD	PAPE	CHEM	PETR	RUBB	NONM	BASI	FABR	MACH	TRAN	COMP	ELEC	MISC	TOT
1980	1905	1849	1849	1794	1882	1848	1905	1929	1911	1910	1889	1889	1889	1880	1889	1889	1882	1874
1981	1910	1850	1850	1791	1888	1848	1902	1960	1921	1900	1899	1899	1891	1907	1891	1891	1888	1874
1982	1896	1793	1793	1762	1858	1855	1857	1963	1874	1886	1836	1836	1867	1881	1867	1867	1858	1840
1983	1891	1866	1866	1816	1902	1884	1883	1935	1948	1944	1917	1917	1890	1949	1890	1890	1902	1890
1984	1879	1878	1878	1794	1922	1892	1905	1955	2001	1976	1955	1955	1922	1949	1922	1922	1922	1918
1985	1891	1850	1850	1829	1920	1897	1914	1941	1950	1989	1955	1955	1918	1961	1918	1918	1920	1919
1986	1907	1883	1883	1803	1916	1884	1894	1957	1970	2008	1946	1946	1909	1901	1909	1909	1916	1918
1987	1908	1920	1920	1864	1926	1884	1905	1993	1911	2109	1952	1952	1919	1925	1919	1919	1926	1928
1988	1915	1903	1903	1829	1938	1893	1910	1974	1995	2008	2002	2002	1943	1925	1943	1943	1938	1945
1989	1947	1898	1898	1847	1940	1902	1924	2064	1975	2005	1987	1987	1942	1917	1942	1942	1940	1946
1990	1979	1873	1873	1817	1930	1894	1919	2057	1957	1980	1973	1973	1931	1909	1931	1931	1930	1934
1991	1919	1901	1901	1820	1919	1892	1916	2012	1948	1967	1955	1955	1921	1902	1921	1921	1919	1920
1992	1929	1913	1913	1860	1940	1913	1939	2045	1984	1986	1985	1985	1935	1910	1935	1935	1940	1945
1993	1930	1915	1915	1876	1959	1910	1946	2033	2010	2026	2007	2007	1969	1956	1969	1969	1959	1971
1994	1952	1930	1930	1870	1973	1912	1941	2047	2016	2044	2044	2044	1972	1994	1972	1972	1973	1988
1995	1969	1896	1896	1861	1964	1916	1957	2006	1986	2029	2002	2002	1974	1984	1974	1974	1964	1975
1996	1962	1898	1898	1888	1961	1905	1961	2064	1964	2034	2015	2015	1962	1989	1962	1962	1961	1975
1997	1970	1926	1926	1858	1972	1924	1931	2007	1971	2030	2041	2041	1971	2002	1971	1971	1972	1989
1998	1946	1904	1904	1839	1960	1899	1946	2044	1970	2049	2010	2010	1957	1984	1957	1957	1960	1969
1999	2002	1914	1914	1835	1975	1912	1963	2022	1989	2061	2036	2036	1945	2039	1945	1945	1975	1985
2000	2009	1910	1910	1833	1962	1898	1911	2023	1969	2039	2038	2038	1928	2025	1928	1928	1962	1965
Average annual growth rates																		
1980-1991	0.1	0.3	0.3	0.1	0.2	0.2	0.1	0.4	0.2	0.3	0.3	0.3	0.2	0.1	0.2	0.2	0.2	0.2
1991-1995	0.6	-0.1	-0.1	0.6	0.6	0.3	0.5	-0.1	0.5	0.8	0.6	0.6	0.7	1.1	0.7	0.7	0.6	0.7
1995-2000	0.4	0.1	0.1	-0.3	0.0	-0.2	-0.5	0.2	-0.2	0.1	0.4	0.4	-0.5	0.4	-0.5	-0.5	0.0	-0.1

Note: For legend, see start of Appendix B

Appendix C: Census-based comparisons and reconciling the 1987 and 1997 ICOP manufacturing benchmarks

In the present benchmark comparison for 1997 for Japan-U.S., we rely on data on output and employment from the National Accounts to calculate relative productivity levels. In previous comparisons, notably those for 1987 (van Ark and Pilat, 1993) these data were taken from the manufacturing Censuses. This methodological change makes it more difficult to compare the consistency of the benchmarks. We have therefore first made a comparison for 1997 along the lines of the 1987 Japan-U.S. comparison of van Ark and Pilat (1993), and then reconciled that outcome with an extrapolation of the results from of the latter study to 1997.

To perform these productivity calculations, several adjustments had first to be made to the industry data from the censuses in both countries. Since in Japan firms with less than four employees are only fully surveyed every three years, we used the estimated figures provided in the *Census of Manufacturing, Report by Industry 1997*. Employment in head offices and auxiliary establishments are also not included in the Census of both countries. For Japan, we obtained these data from the *Establishment and Enterprise Census* for 1996. We considered workers in 'Shops/eating and/or drinking establishments', 'Offices/sales offices', 'Shipping centers/delivery centers/garages', 'Warehouses/oil tanks for domestic use' and 'Others (schools, hospitals, temples/shrines, hotels/inns, bathhouses, etc.)' as head office and auxiliary employment. The remainder of the persons work in 'Factories/workshops/mining stations' and 'Establishments with vague distinction from an ordinary dwelling due to appearance'. The ratio of head office and auxiliary employment to total employment was applied to employment from the Census. For total manufacturing, this leads to an auxiliary ratio of 21.7 percent. This is somewhat higher than the 15.1 percent that was used by van Ark and Pilat (1993) for the 1987 comparison.

In the U.S., under the new NAICS classification, head office and auxiliary employment is allocated to separate industries like 'Management of Companies and Enterprises'. For 1997, we therefore rely on data for head office and auxiliary employment from the *1996 Annual Survey of Manufacturers* (ASM), which is the last Survey taken under the old SIC classification system. The auxiliary ratio from the 1996 ASM was 7.2 percent, which we applied to 1997 employment. This ratio is considerably smaller than in Japan.

In Table C1, we show output and employment based on the Census of Manufacturers 1997 in Japan and the 1997 Economic Census for the United States. Since the data on hours worked do not differ much between both countries, we only report value added per person employed. For comparison, we also report value added per person employed based on the National Accounts from Table 4. For total manufacturing, differences are small, but for a number of branches, the results are very different. It is hard to pin down exactly what is causing these differences, but an important difference is the definition of value added. Census value added still includes purchased services, while value added in the National Accounts excludes all purchased intermediates. From that perspective, the figures from the National Accounts should give a 'cleaner' definition of value added. The situation is further complicated by the fact that the 1997 U.S. Economic Census is based on new surveys and a new classification system (NAICS), while the U.S. National Income and Product Accounts are still based on the old classification system (SIC87). Classifications have been adjusted to the extent possible, but differences may still arise from this switch. One exception is that in the current data for Japan, plastic products are included as part of miscellaneous manufacturing.

Table C1, Output, employment and productivity based on the Census in Japan and the United States for 1997 and a comparison with results based on the National Accounts

	Value added		*Persons employed*		*Productivity per person*	
	Japan (bil. Yen)	U.S. (mil. US$)	Japan (1000s)	U.S. (1000s)	Census (U.S.=100)	Nat. Accounts (U.S.=100)
Food and kindred products	13455	221072	1581	1782	31.7	35.5
Textile mill products	1916	37111	338	657	66.2	31.1
Wearing apparel	2355	33905	672	751	46.0	68.1
Leather products and footwear	370	5011	79	89	36.5	56.9
Wood products	1615	39931	250	674	41.8	27.1
Paper products, printing and publishing	11282	219212	1185	2302	65.2	82.3
Chemicals and allied products	13213	227196	502	1150	79.8	70.8
Petroleum and coal products	1146	36307	45	143	66.6	190.1
Rubber and plastic products	6301	81516	688	1066	104.5	116.2
Non-metallic mineral products	5389	49523	518	531	88.0	86.0
Basic metal products	8860	68990	526	631	118.7	156.9
Fabricated metal products	8461	132794	980	1820	66.9	51.6
Machinery and equipment	13433	134495	1348	1493	100.7	132.1
Transport equipment	15150	225991	1090	2015	96.2	74.7
Office, accounting and computing machinery	3047	43608	172	284	90.5	60.2
Electrical machinery and instruments	21698	266046	2127	2235	86.9	99.9
Furniture and miscellaneous manufacturing	3924	95747	610	1379	65.9	78.7
Total manufacturing	131614	1918457	12712	19004	72.9	75.3

In Table C2, we compare the Census-based results for the 1997 benchmark with the results for the 1987 benchmark from van Ark and Pilat (1993). To make this comparison possible, we extrapolated the figures from van Ark and Pilat (1993) to 1997 using the growth rates of (current) value added, the manufacturing deflators and employment from the National Accounts.[23] Table C2 therefore shows what the results would have been if we had simply extrapolated from van Ark and Pilat (1993) and what the results are when based on new manufacturing UVRs and data from the 1997 Census in both countries.

As a bottom-line it is clear that the 1997 benchmark leads to productivity level in Japanese manufacturing relative to the U.S. that is 7.1 percentage points lower than the (extrapolated) 1987 benchmark. This difference is decomposed in the effect of differences between the actual census value added data (as recorded in 1997 statistics) and the extrapolated census value added (extrapolated from 1987), the differences in actual and extrapolated employment and the effect of a different UVR sample for 1987 vis-à-vis 1997. Differences between the extrapolated 1987 census-based and the 1997 census-based benchmark data output and employment are relatively modest for Japan, but for the U.S. differences these are larger in the case of value added. As mentioned above, there has been a switch to a new classification system in the U.S., which may well affect comparisons across Census years. However, the biggest difference is in the PPP, which is around 7 percent higher for the 1997 benchmark than for the extrapolated 1987 benchmark. Part of this may be due to a changing output structure in both countries. However, if we impose the 1997 output structure on the 1987 branch UVRs, the total manufacturing PPP for 1987 extrapolated to 1997 becomes 127.6 instead of 131.0. In other words, changing economic structure is a relatively minor factor and increases the differences between the benchmarks. After eliminating structural effects across branches, all differences in the aggregate UVR have to be ascribed either to structural change within each branch or to a different sample of UVRs. While we cannot fully reconcile these differences, it would seem that our 1997 benchmark is at least somewhat more reliable because the number of matches is somewhat larger (215 versus 190) while the output coverage by product matches is about the same (and even somewhat

[23] See the ICOP Industry Database, www.eco.rug.nl/ggdc.

higher in Japan). Moreover, we have made somewhat greater adjustment for quality differences in this study, in particular because of the use of a hedonic UVR for cars and the use of a quality-adjusted UVR for computers.

Table C2, Comparison of the 1987 and the 1997 benchmark of total manufacturing labour productivity levels in 1997 for Japan relative to the United States

		1997 level based on 1987 benchmark Census-based	1997 level based on 1997 benchmark Census-based	Difference (%)
Value added	Japan	129645	131614	1.5
	U.S.	1805987	1918457	6.0
Persons employed	Japan	13062	12712	-2.7
	U.S.	18675	19004	1.7
PPP	Japan/U.S.	131.0	140.6	7.1
Productivity	Japan/U.S.	78.3	72.9	-7.1

In terms of contributions to the overall difference, differences in output and employment in Japan and the U.S. almost cancel out (productivity is around 4 percent higher under the 1997 benchmark in both countries than under the 1987 benchmark). The remainder can be attributed to the difference in the UVR.

A similar story can be told for the relative unit labour cost calculations. In van Ark and Pilat (1994), Japanese ULC in 1990 is 99.5 percent of the U.S. level based on their 1987 benchmark, while our results for the 1997 benchmark show a level of 100.6 percent in 1990. This difference can be partly ascribed to the higher PPP we find, but also to methodological changes. Recall that ULC is defined as labour compensation per hour divided by productivity per hour. Van Ark and Pilat (1994) calculate labour compensation per hour based on the National Accounts, just like we do. However, productivity per hour is calculated from the Census. Still, these results are sufficiently close that it should not be an important worry.

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